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**UCRL- 95507**  
**PREPRINT**

## **EXPLODING BRIDGE WIRE INITIATION OF HIGH EXPLOSIVES**

**Alan M. Frank**

This paper was prepared for presentation at  
11th Annual Joint Firing Systems Conference

**10/15-16/86**

**Lawrence  
Livermore  
National  
Laboratory**

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## Exploding Bridge Wire Initiation of High Explosives \*

Alan M. Frank

Lawrence Livermore National Laboratory

We are establishing a laboratory for the microscopic examination of exploding bridge initiation of high explosives. In particular we wish to examine the partition of energy of the EBW and its mechanism(s) for transfer to HE. We are using recently developed techniques in micro framing<sup>1</sup> and streak photography and spectroscopy.

At the present time we have built up a fireset and diagnostics and are comparing electrical burst data with that predicted by the FIRESET code<sup>2</sup>. A high resolution 15ns framing camera is currently functional and has been used to examine self illumination effects. Three illumination systems are being prepared to provide single short pulse (2nS) laser illumination, multiple pulse laser illumination and long pulse (µS) flashlamp illumination. These illuminators will allow various forms of direct micro-photography, shadow and Schlieren photography. These techniques will be used to provide direct measurement of shock velocities and histories. We are also investigating the direct measurement of pressure in and behind the shock using the spectral shift in the fluorescence of certain dyes<sup>3</sup>. For this application we are building an intensified imaging spectrograph. We will examine the status and plans of the laboratory and present some initial results.

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<sup>1</sup> Frank & Hein, High Speed Photography, SPIE Vol 491, 1984

<sup>2</sup> Prof. Ronald S. Lee, Kansas State Univ., To be published.

<sup>3</sup> Huston, Justus & Campillo, Chem Phys Lett 118;3 26July85

\*Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract No. W-7405-ENG.48.



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**EXPLODING WIRE INITIATION  
OF  
HIGH EXPLOSIVES  
(A NEW FACILITY)**

**ALAN M. FRANK**

**PRESENTED AT THE  
ELEVENTH ANNUAL FIRING SYSTEMS  
CONFERENCE  
OCTOBER 15-16, 1986**

THE PURPOSE OF THE LABORATORY IS TO EXAMINE  
THE MECHANISMS OF EBW INITIATION OF HE.

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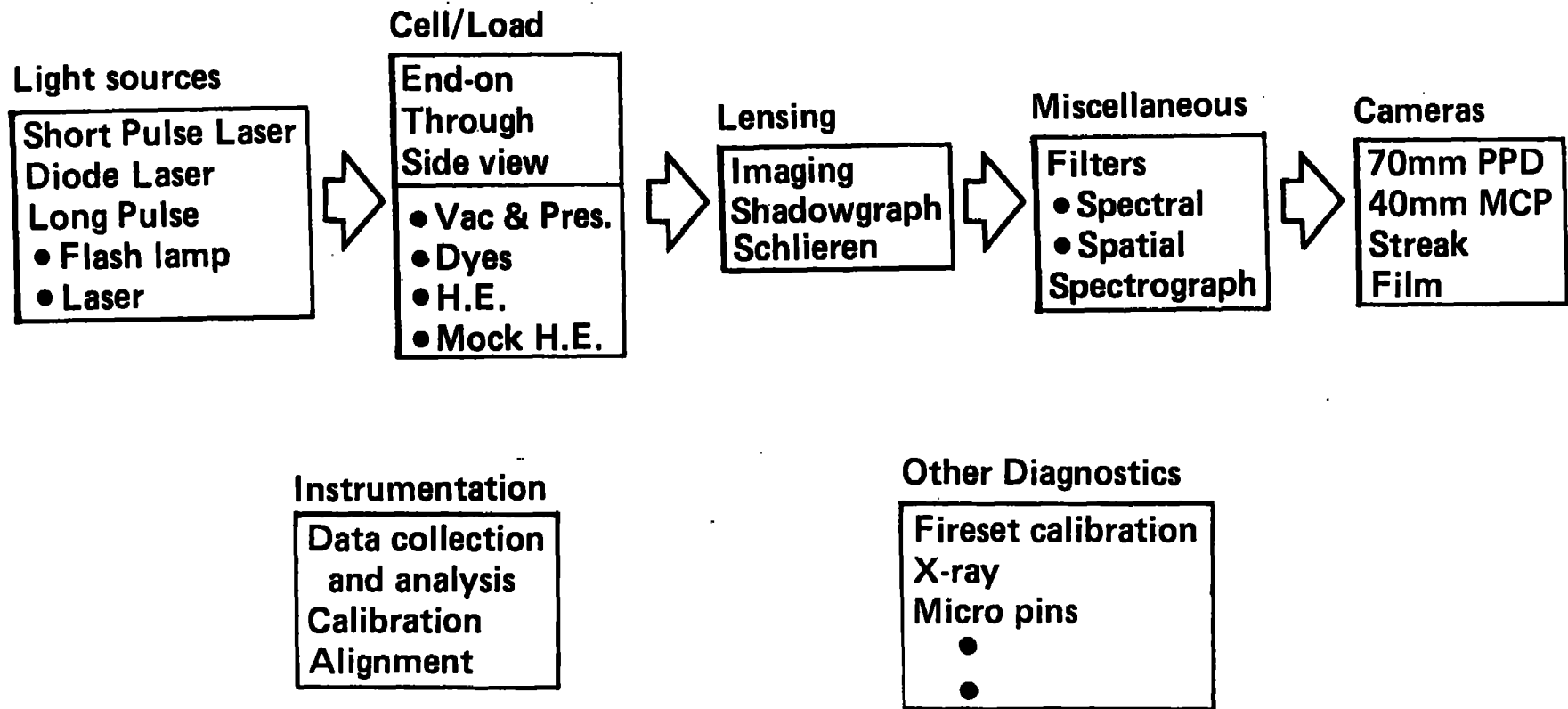
- INPUT ENERGY IS WELL CHARACTERIZABLE VIA ELECTRICAL PARAMETERS AND MEASUREMENTS (I&V).
- ENERGY DISTRIBUTED INTO:
  - HEATING, MELTING, AND VAPORIZATION
  - SHOCK(S) IN MEDIUM
  - KINETIC ENERGY
  - RADIATION
  - PLASMA HEATING OF MEDIUM AND WIRE
- ENERGY PARTITION AND ITS DEPENDENCE ON INPUT PARAMETERS AND INITIAL CONDITIONS IS NOT UNDERSTOOD.
- WHAT FORM(S) OF ENERGY ARE RESPONSIBLE FOR HE INITIATION?

## SPECULATIVE ENERGY BUDGET (SE-1)



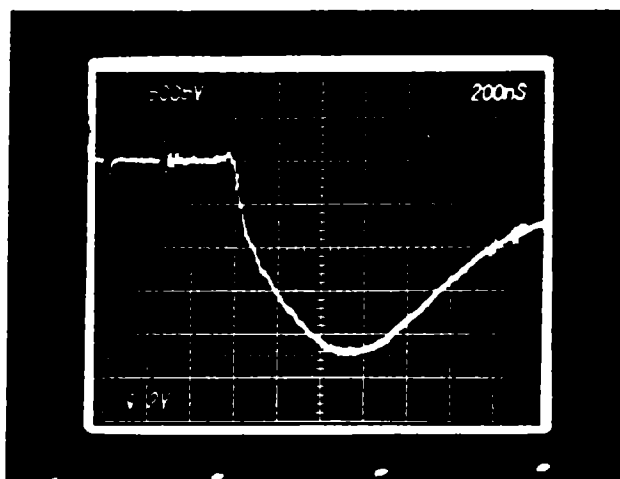
● TOTAL ENERGY AVAILABLE ( $1/2 CV^2$ )	1J
● JULE HEATING OF CIRCUIT ( $I^2R$ )	.5J
● ENERGY LEFT IN CIRCUIT (AT END OF PRIMARY PULSE)	.5J
● ENERGY TO VAPORIZE WIRE (HANDBOOK CALC)	$10^{-2}J$
● SHOCK (EST FROM PHOTO VEL)	$8 \times 10^{-3}J$
● KINETIC ENERGY (EST FROM PHOTO VEL)	$3 \times 10^{-3}J$
● RADIATION (FROM LITERATURE TEMP $3 \times 10^3 - 10^5$ K)	$10^5 - 1J$

# Tools for EBW Experiments



7/23/86

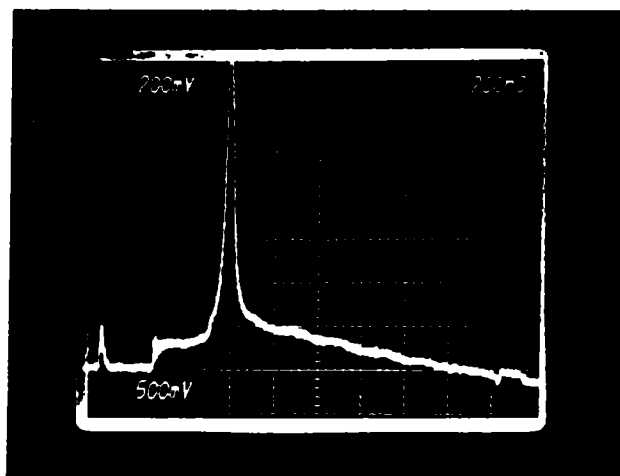
PIN

SE-1 in Air  
- 1494V

ND = 0 at 750mm

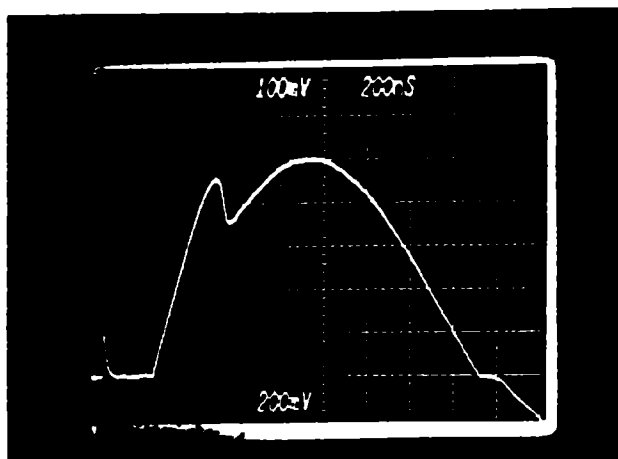
into 50Ω no atten.

V



200x atten

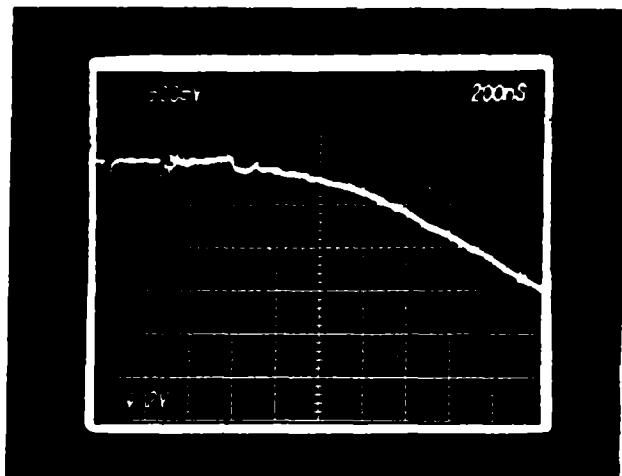
I



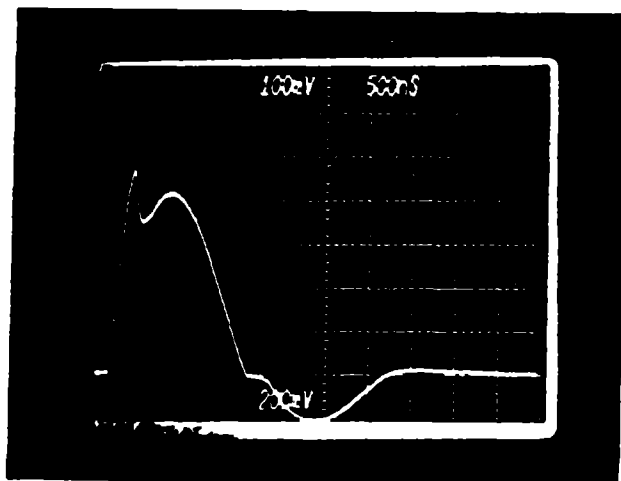
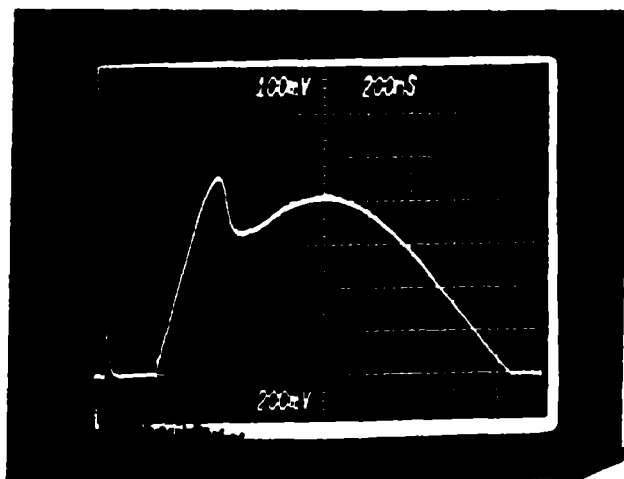
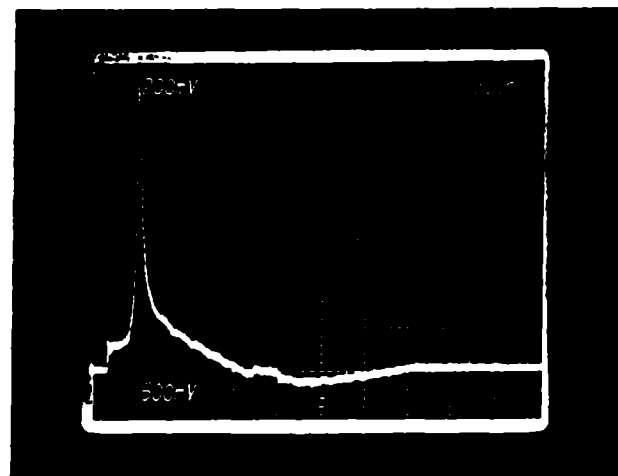
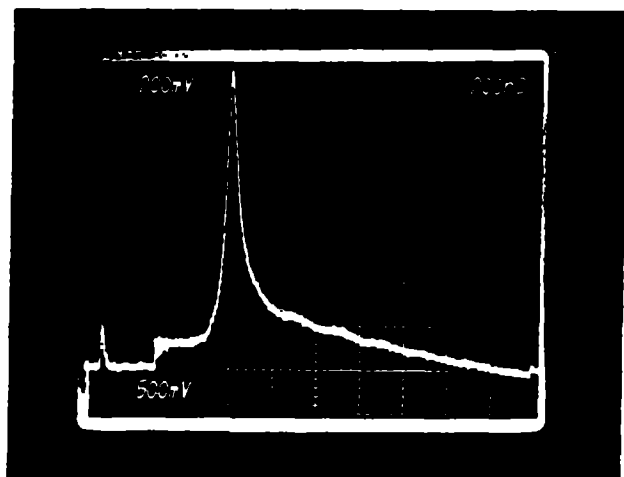
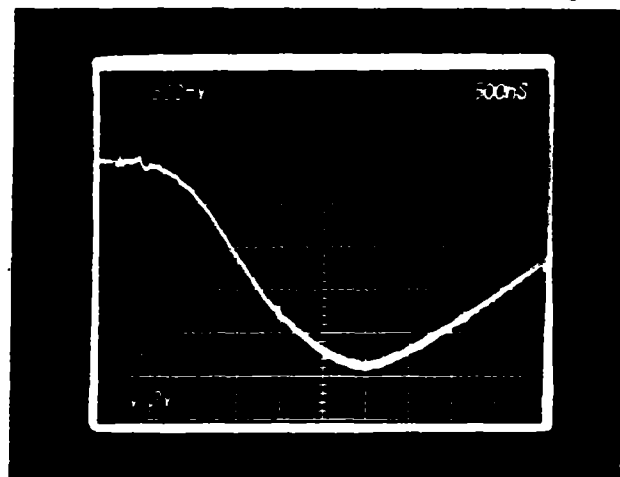
100x atten



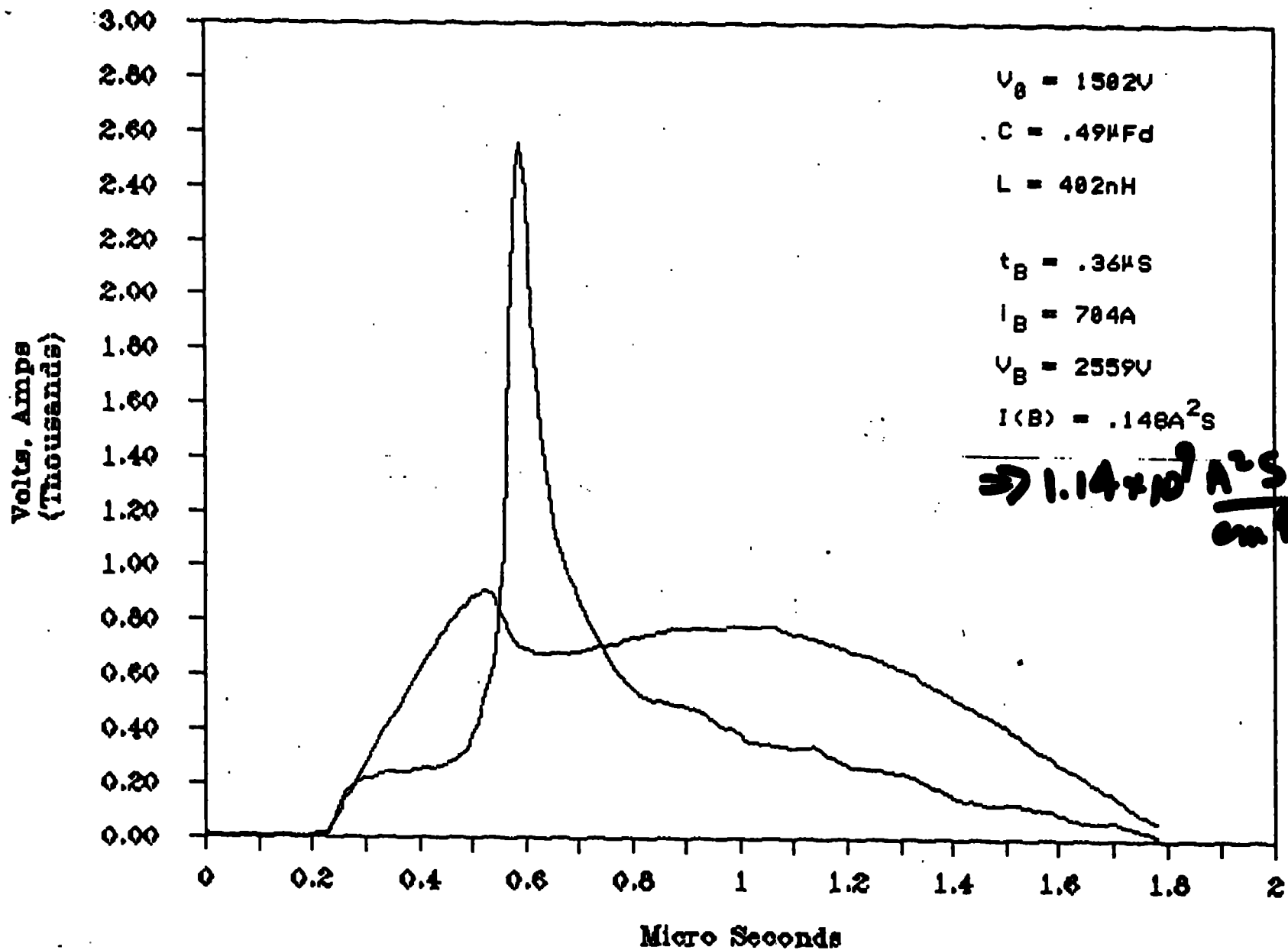
SE-1 in water  
1500V



1504V



# SE-1 in WATER

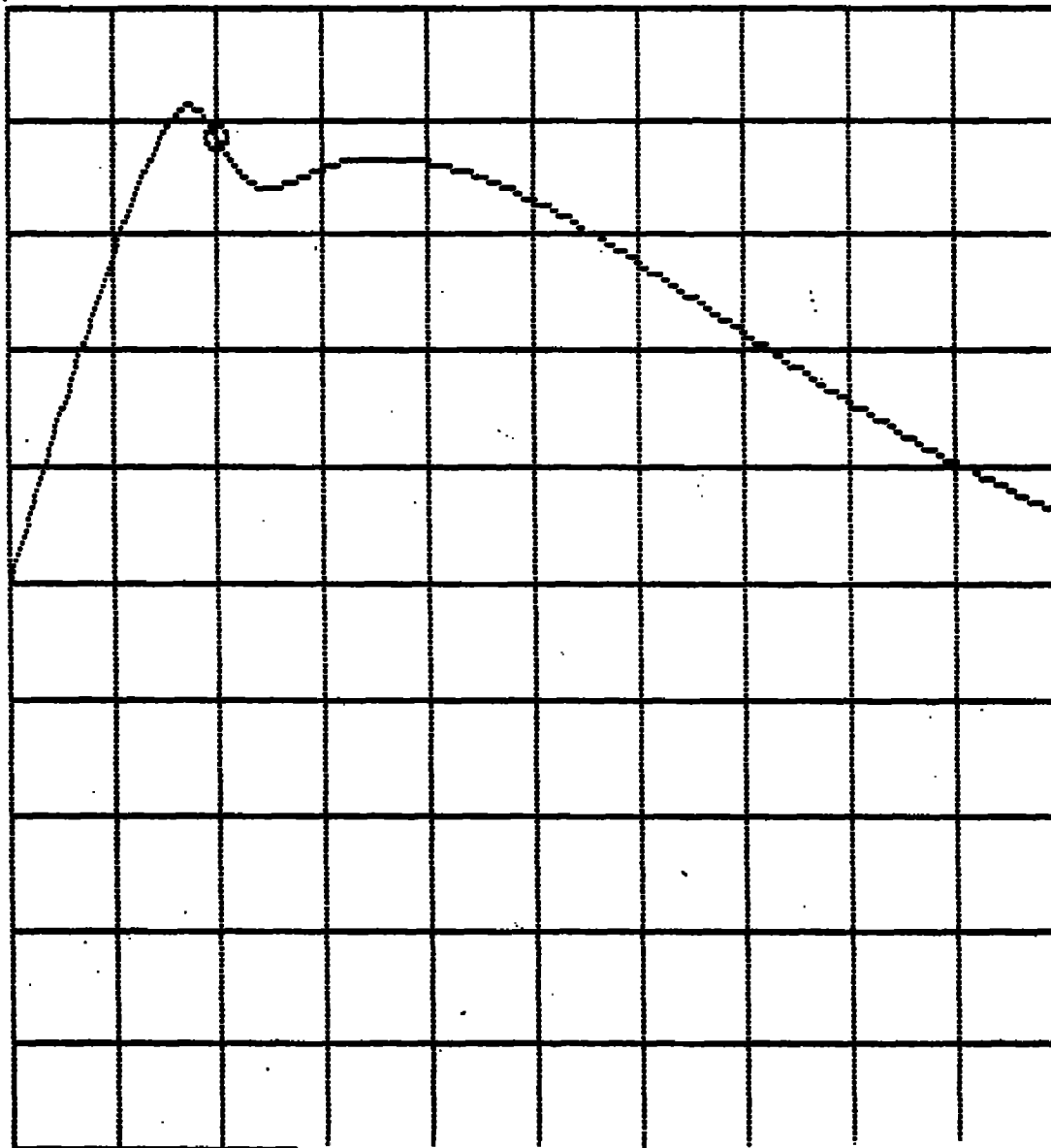


# FIRESET CODE

.491  $\mu$ f  
273 m $\Omega$   
370 nh  
1.5 kv

gold action 1.58

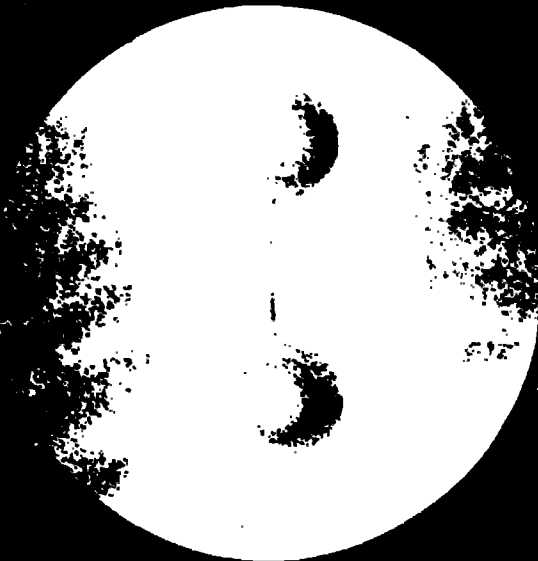
1.0 kA



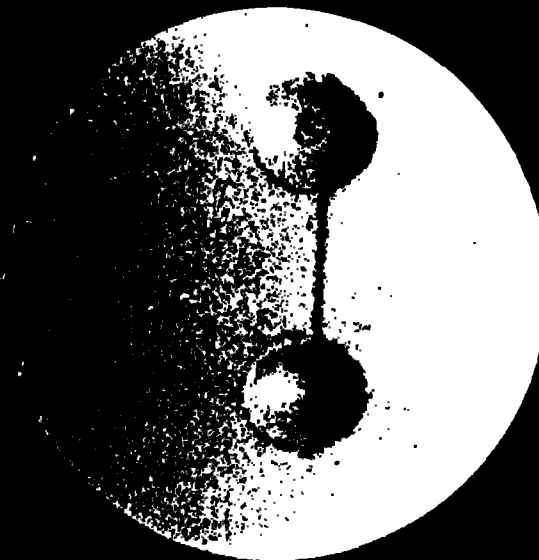
REF:  
PROP Ron LEE  
K. S. U.

# INCREASING ILLUMINATOR BANDWIDTH DECREASES SPECKLE

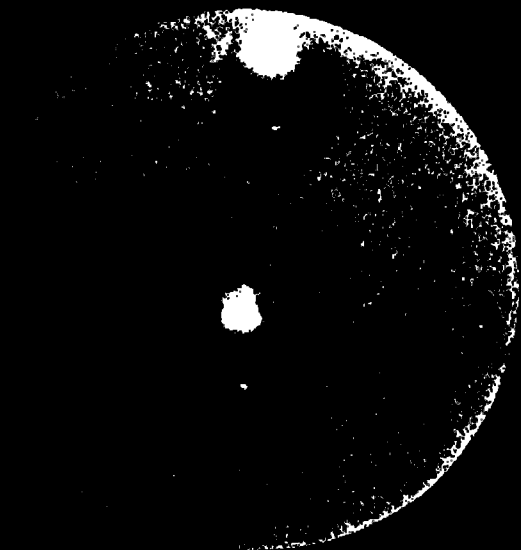
$2\omega$ -YAG  $\lambda = 532 \text{ nm}$   
 $\Delta\lambda = 0.03 \text{ nm}$   
 $\Delta t = 8 \times 10^{-9} \text{ s}$



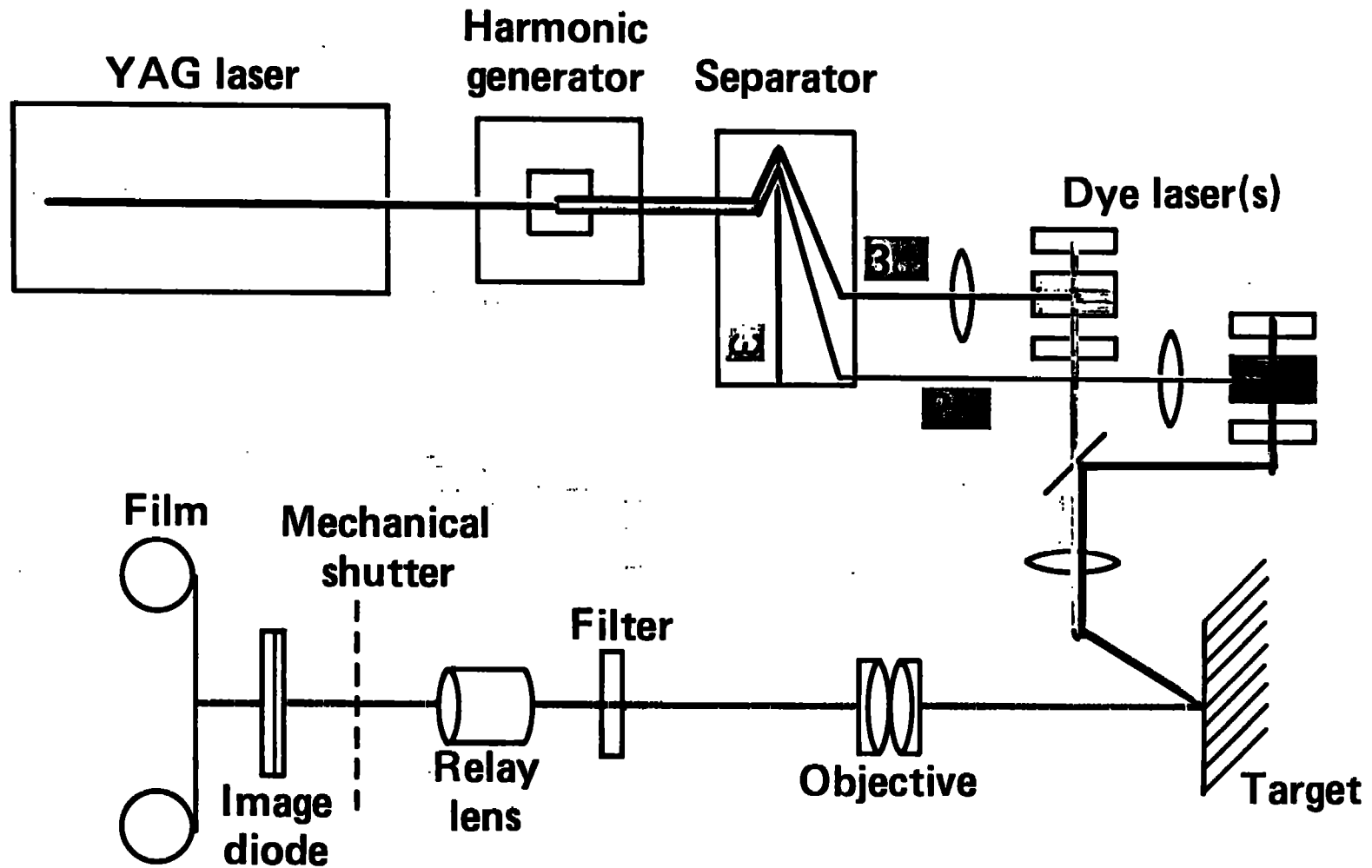
DYE (Cu -500)  
 $\lambda = 508 \text{ nm}$   
 $\Delta\lambda \sim 15 \text{ nm}$   
 $\Delta t = 8 \times 10^{-9} \text{ s}$

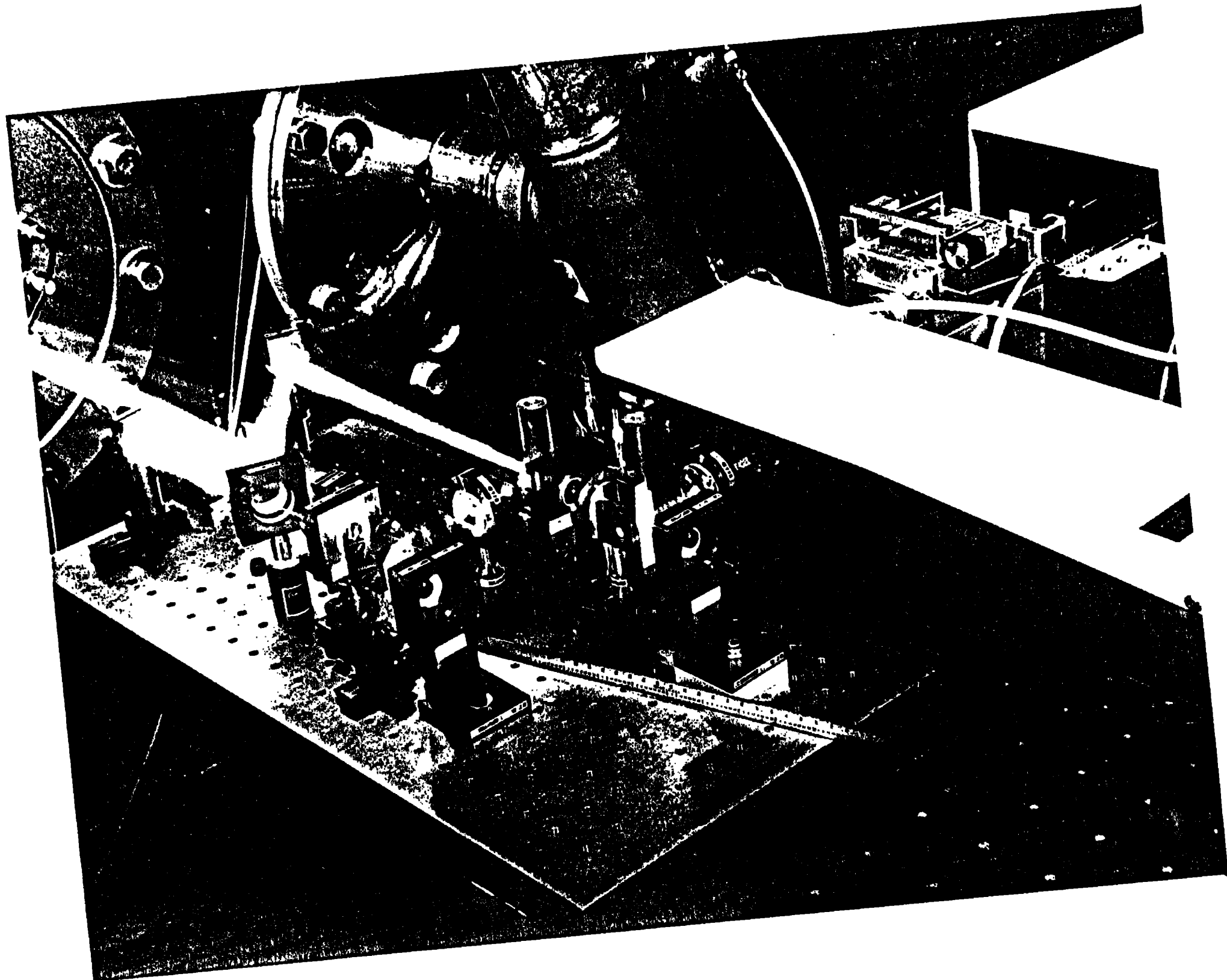


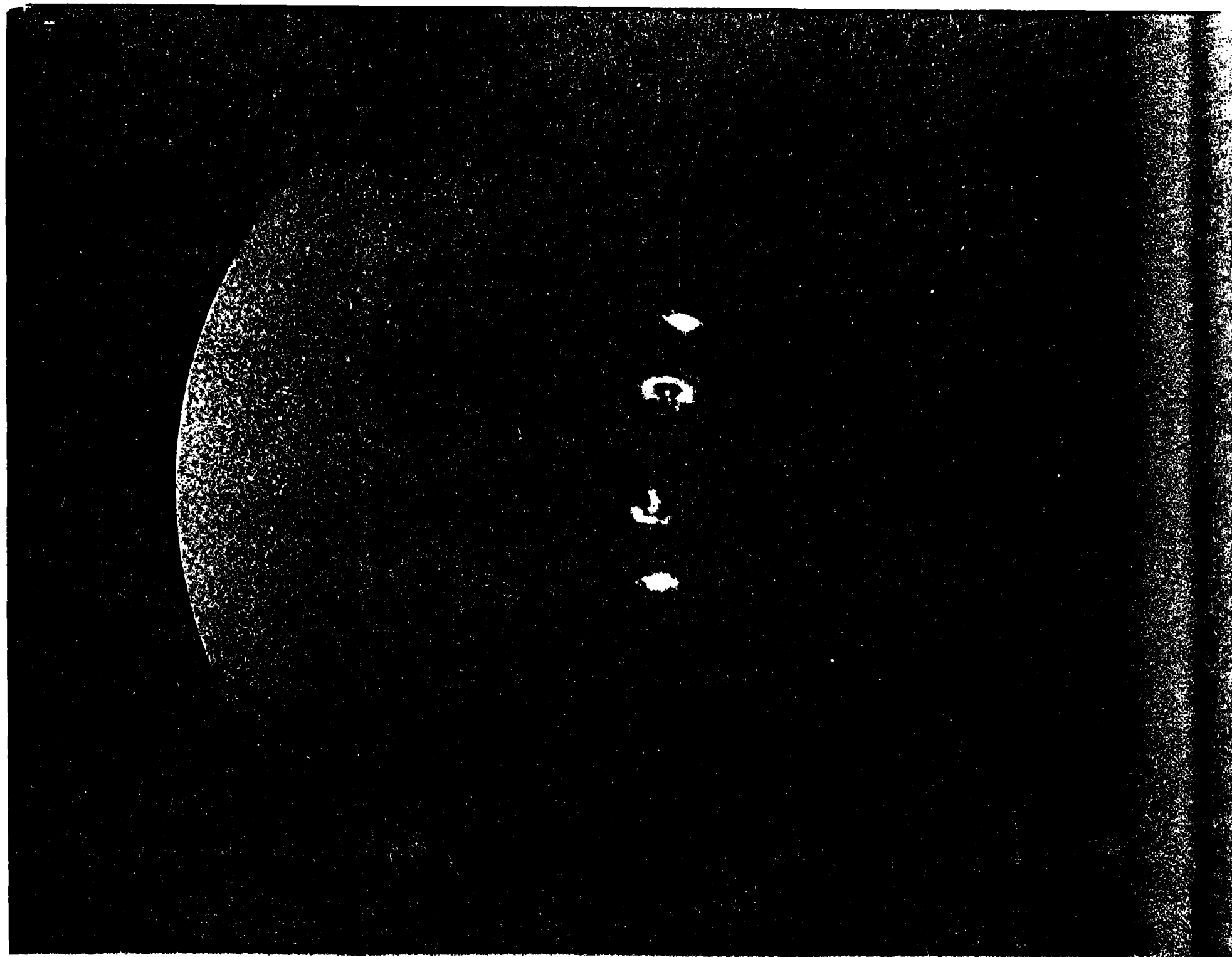
White light  
 $\Delta t = 0.02 \text{ s}$

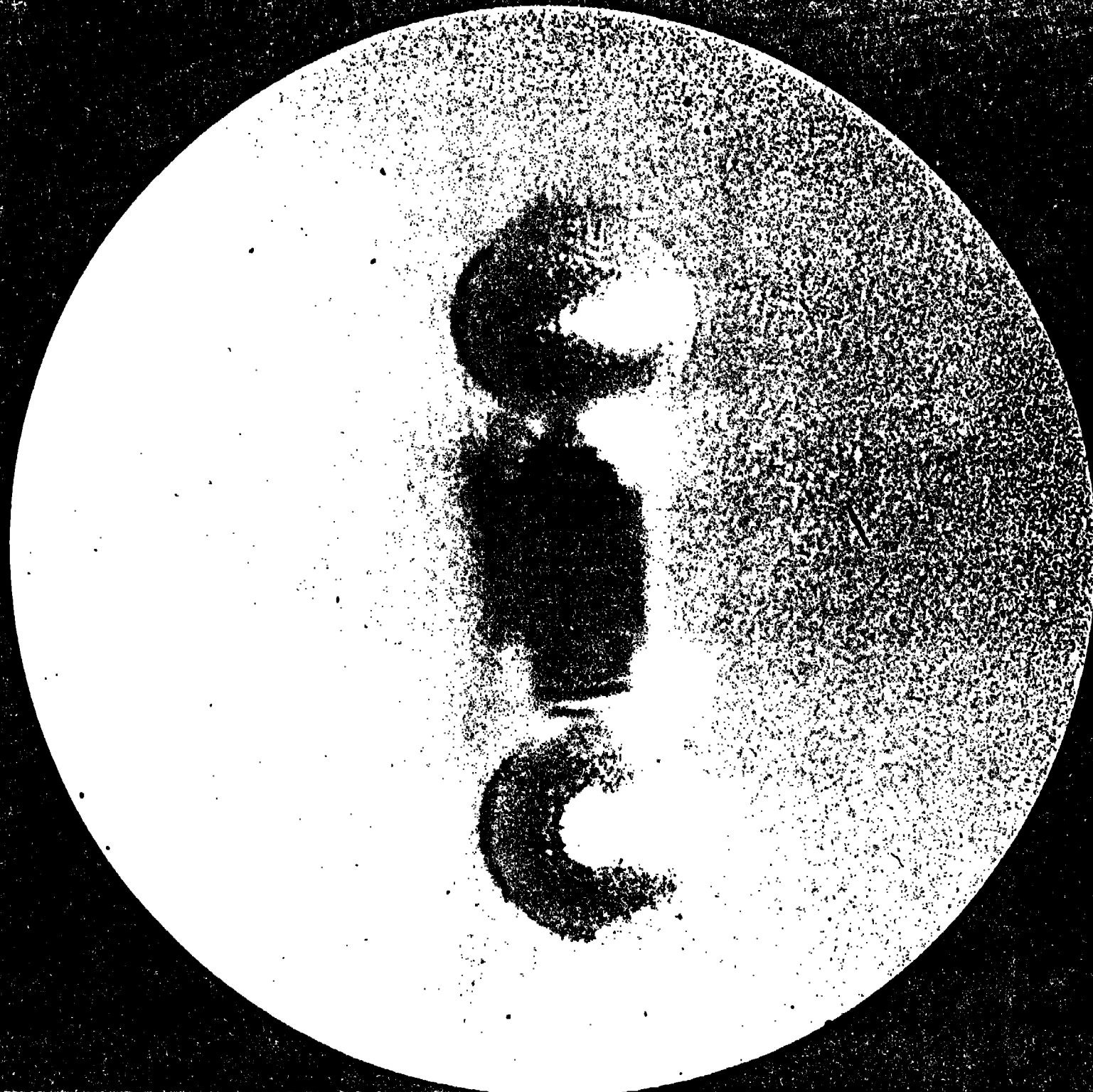


# Nano-second Microscope



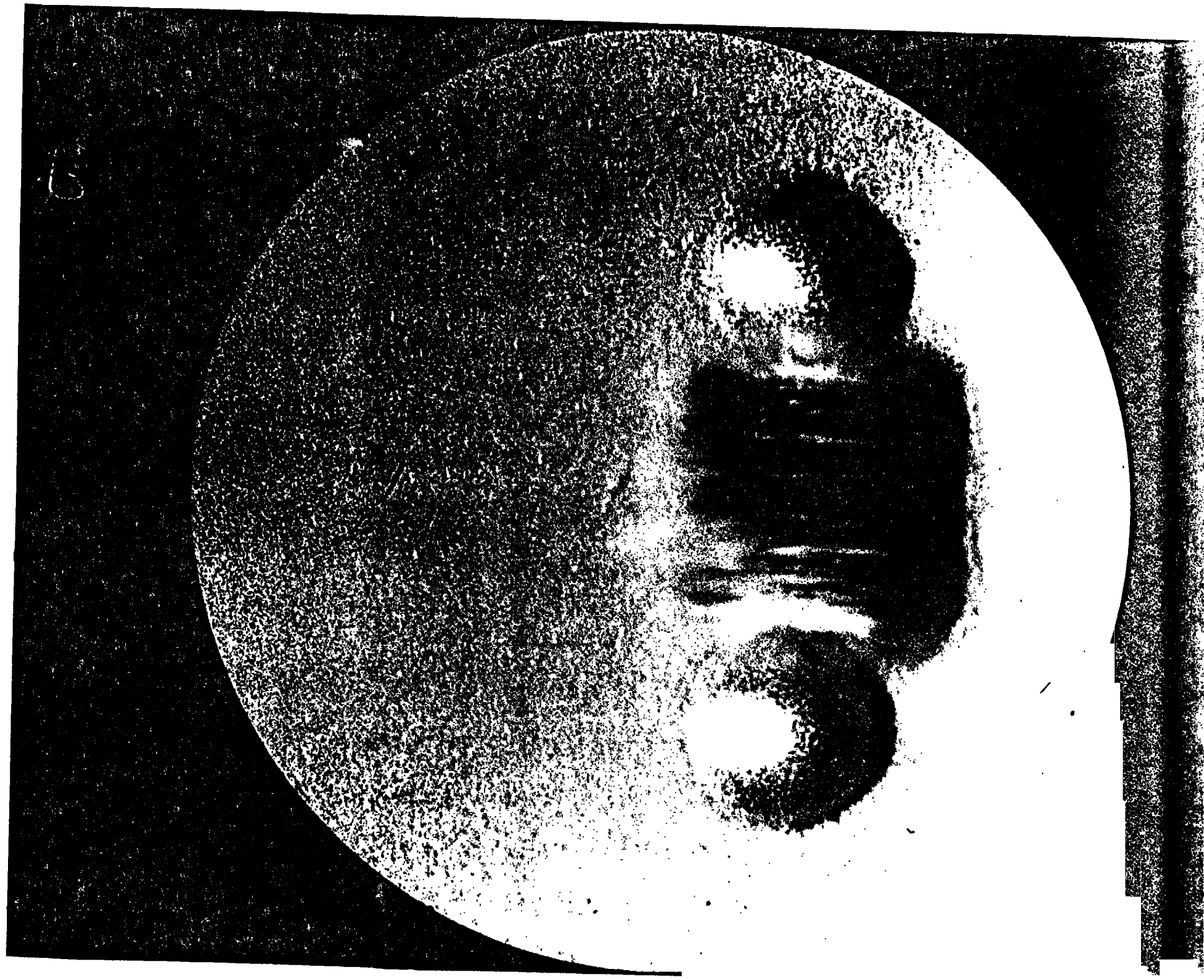


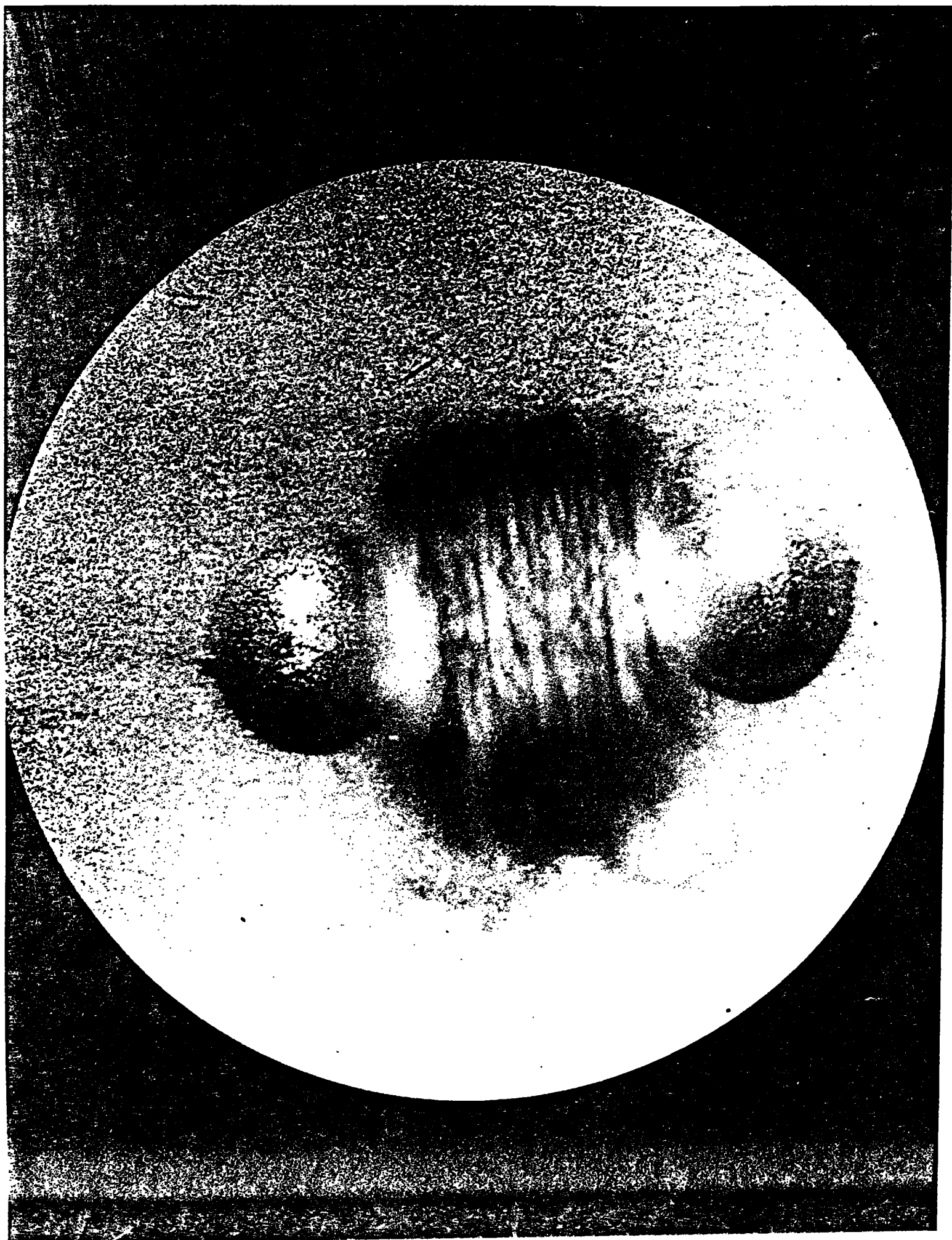




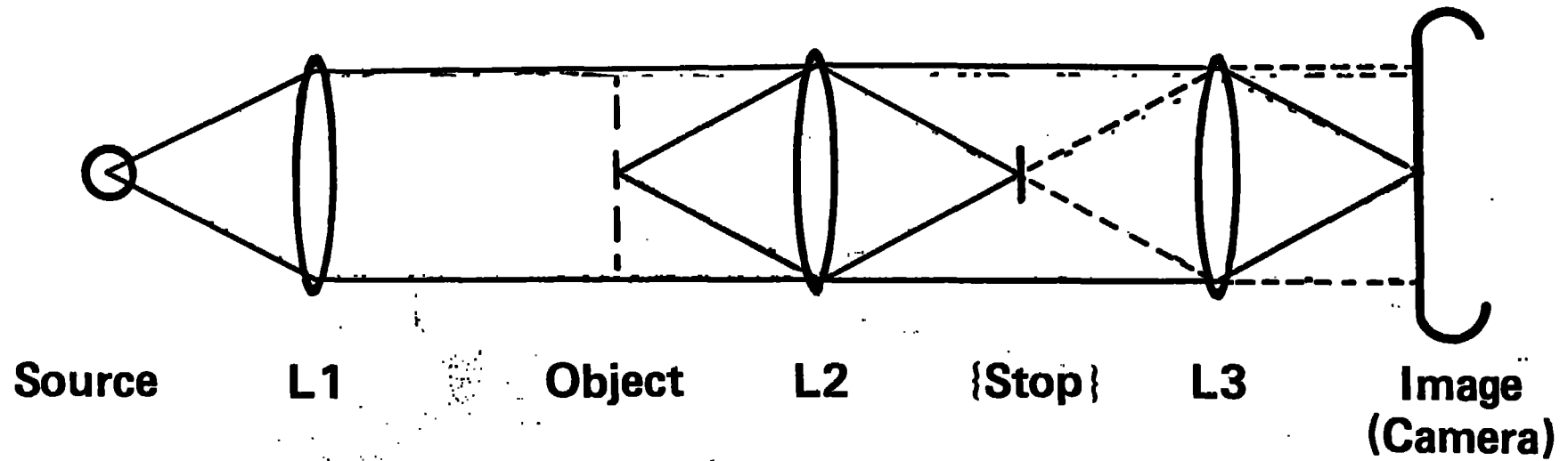
18







# Shadowgraph / {Schlieren}



O<sub>2</sub>N<sub>2</sub> H<sub>2</sub>O

A<sub>u</sub> OH

130 925.4 940.0

150 872.2 927.7

867.5 882.9

859.7

854.1

695 703.6 695.7

705

595 595.6

605 596.2

602.6

6001 (No)

595.9

485

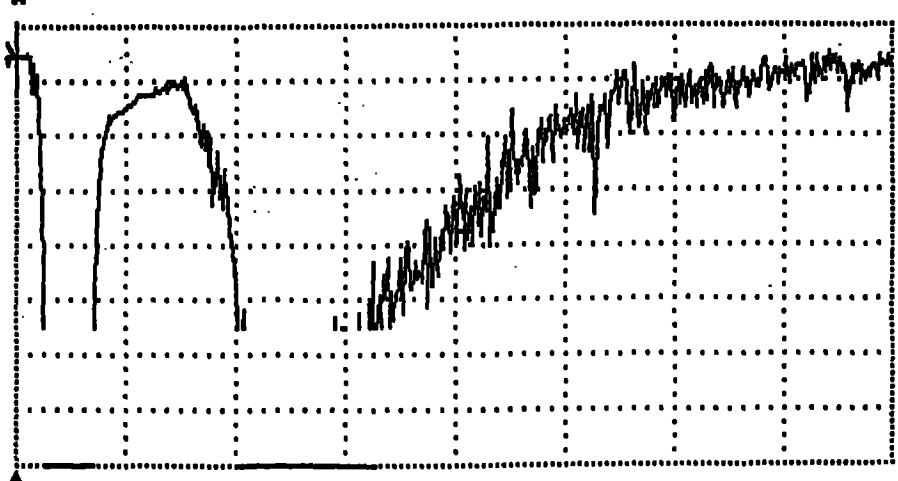
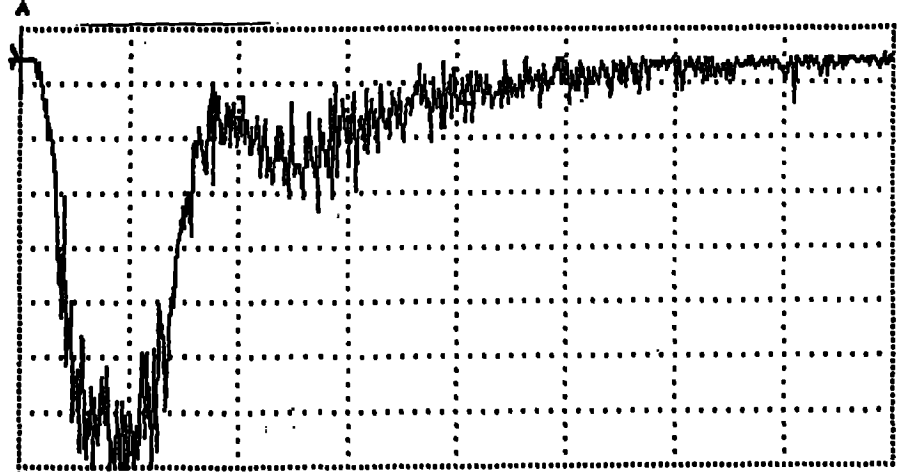
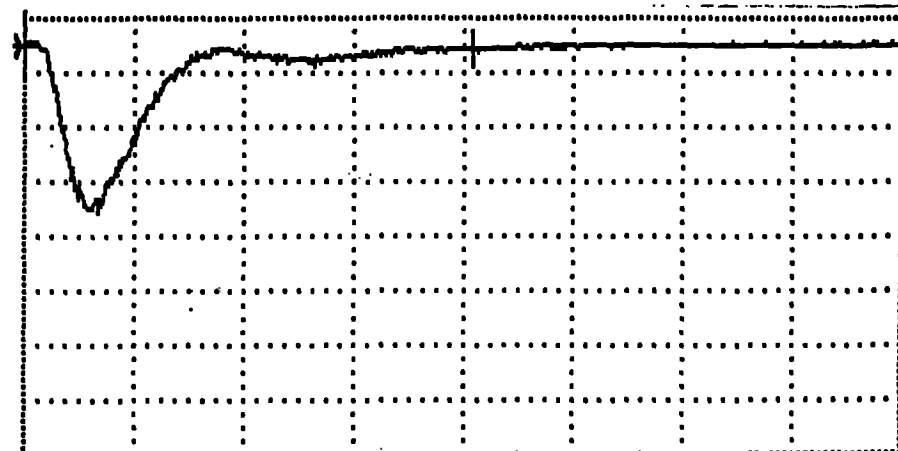
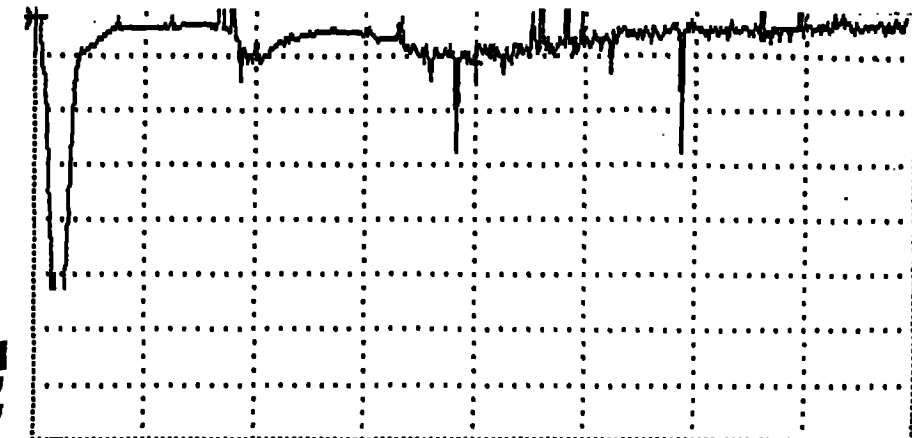
495 495.0

100 mV/div  
5 us/div

100 mV/div  
5 us/div

50 mV/div  
5 us/div

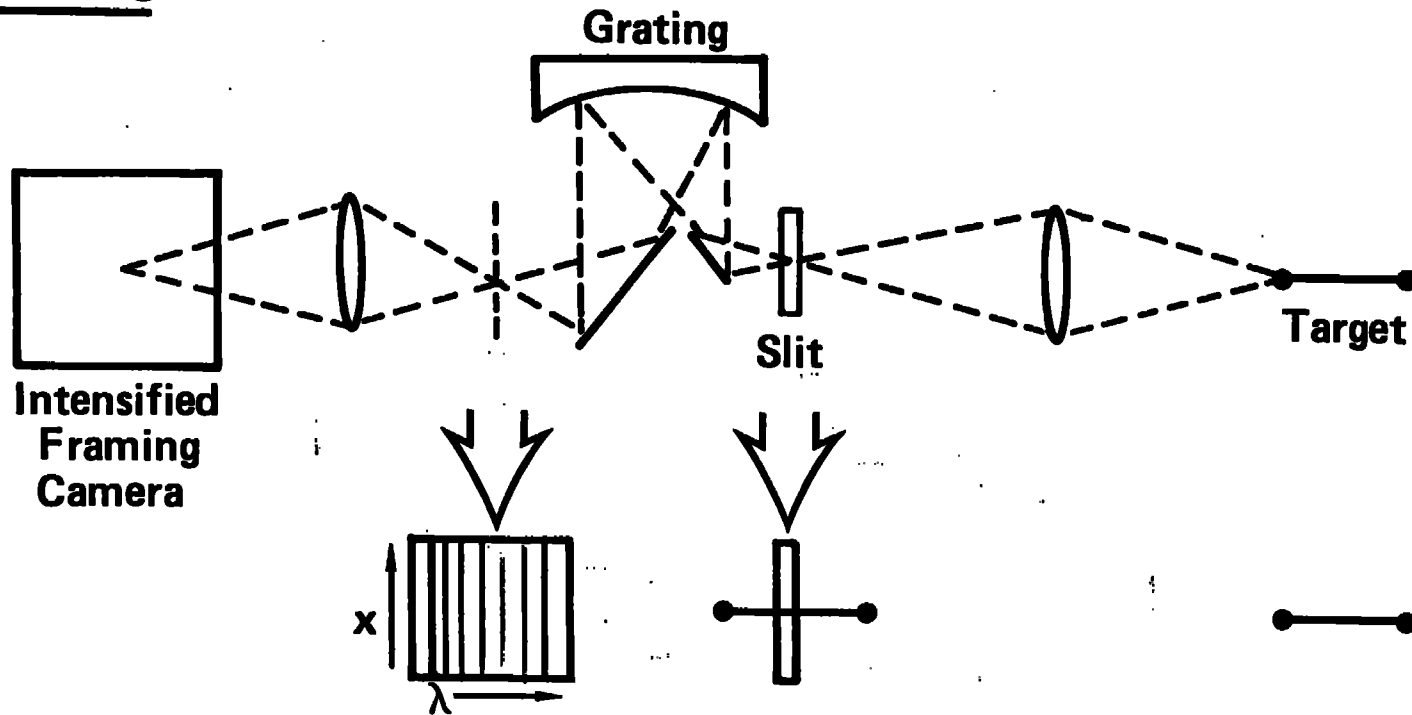
100 mV/div  
5 us/div



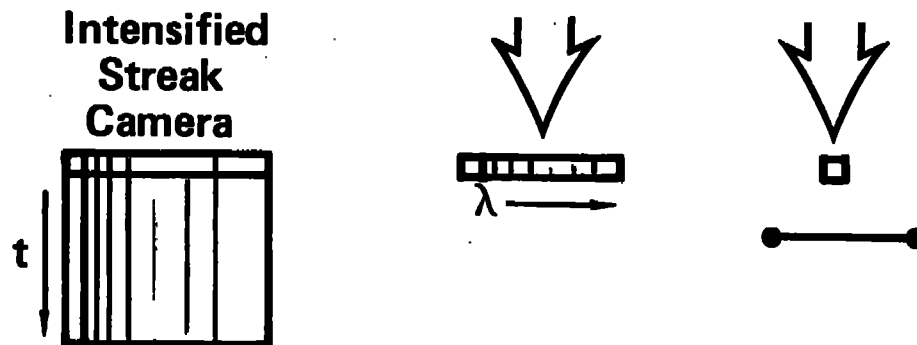
# Spectrograph

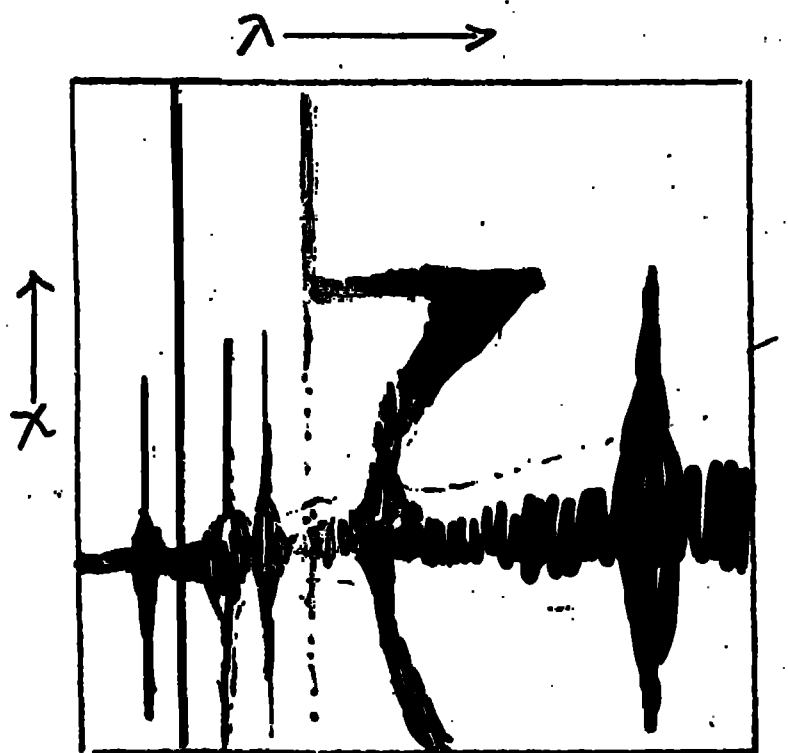
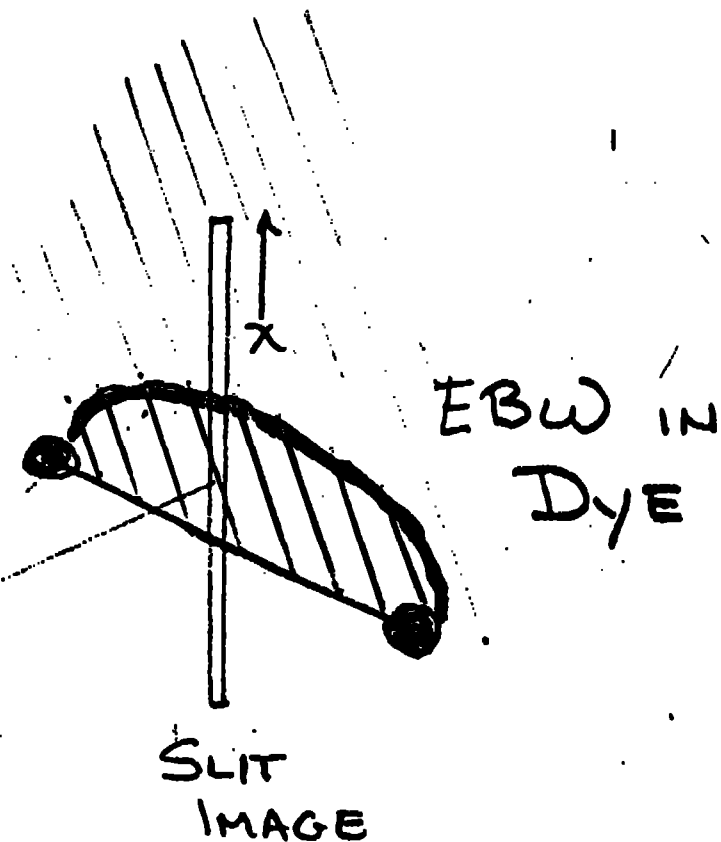
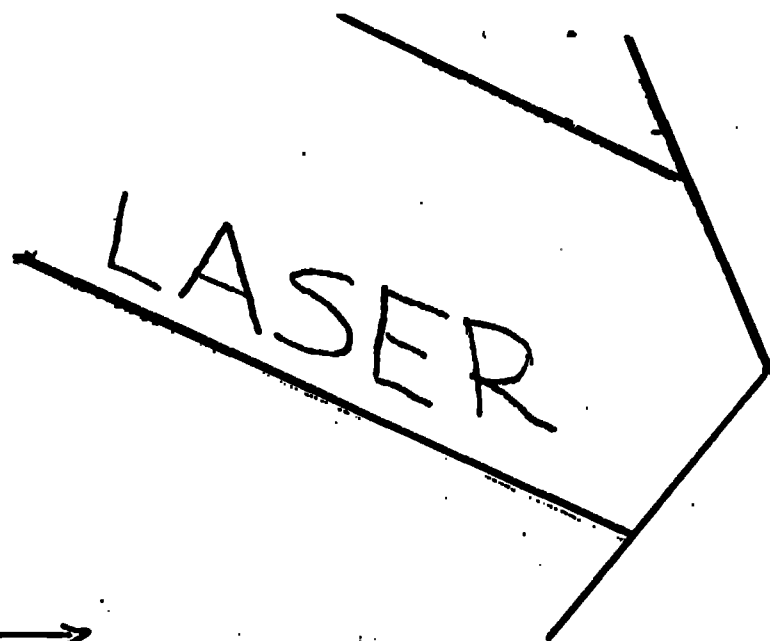


## Imaging



## Streak





IMAGING  
SPECTROMETER